Professor Plana

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ABSTRACT

OF A PAPER ENTITLED

OBSERVATIONS ON THE TEMPLE OF SERAPIS AT POZZUOLI;

WITH

REMARKS ON CERTAIN CAUSES WHICH MAY PRODUCE GEOLOGICAL CYCLES OF GREAT EXTENT.

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A PAPER was read, entitled, "Observations on the Temple of Serapis at Pozzuoli, near Naples; with Remarks on certain Causes which may produce Geological Cycles of great Extent. In a Letter to W. H. Fitton, M.D., from Charles Babbage, Esq."

The author commences this paper with a general description of the present state of the Temple of Serapis, and gives the measurement of the three marble columns which remain standing, and which, from the height of 11 feet to that of 19, are perforated on all sides by the *Modiola lithophaga* (of Lamarck); the shells of that animal remaining in the holes formed by them in the columns. A description is then given of the present state of twenty-seven portions of columns, and other fragments of marble, and also of the several incrustations formed on the walls and columns of the temple.

The conclusions at which the author arrives are—

1. That the temple was originally built, at or nearly at the level of the sea, for the convenience of sea-baths, as well as for the use of the hot spring which still exists on the land side of the temple.

2. That at some subsequent period the ground on which the temple stood subsided slowly and gradually; the salt water, entering through a channel which connected the temple with the sea, or by infiltration through the sand, mixed itself with the water of the hot spring containing carbonate of lime, and formed a lake of brackish water in the area of the temple, which, as the land subsided, became deeper, and formed a dark incrustation.

The proofs are, that sea-water alone does not produce a similar incrustation; and that the water of the hot spring *alone* produces an incrustation of a different kind; also, that Serpulæ are found adhering to this dark incrustation; and that there are lines of *water-level* at various heights, from 2·9 feet to 4·6 feet.

3. The area of the temple was now filled up to the height of about seven feet with ashes, tufa, or sand, which stopped up the channel by which sea-water had been admitted. The waters of the hot spring thus confined converted the area of the temple into a lake, from which an incrustation of carbonate of lime was deposited on the columns and walls.

The proofs are, that the lower boundary of this incrustation is irregular; whilst the upper is a line of water-level, and that there are many such lines at different heights;—that salt water has not been found to produce a similar incrustation;—that the water of the Piscina Mirabile, which is distant from the sea, but in this immediate neighbourhood, produces, according to an examination by Mr. Faraday, a deposit almost precisely similar;—that no remains of Serpulæ, or other marine animals, are found adhering to it.

4. The temple continuing to subside, its area was again partially filled with solid materials; and at this period it appears to have been subjected to a *violent* incursion of the sea. The hot-water lake was filled up, and a new bottom produced, entirely covering the former bottom, and concealing also the incrustation of carbonate of lime.

The proofs are, that the remaining walls of the temple are highest on the inland side, and decrease in height towards the sea side, where they are lowest;—that the lower boundary of the space perforated by the marine Lithophagi is, on different columns, at different distances beneath the uppermost or water-level line;—that several fragments of columns are perforated at the ends.

5. The land continuing to subside, the accumulations at the bottom of the temple were submerged, and Modiolæ attaching themselves to the columns and fragments of marble, pierced them in all directions. The subsidence continued until the pavement of the temple was at least nineteen feet below the level of the sea.

The proofs are derived from the condition of the columns and fragments.

6. The ground on which the temple stood appears now to have been stationary for some time, but it then began to rise. A fresh deposition, of tufa or of sand, was lodged, for the third time, within its area,—leaving only the upper part of three large columns visible above it.

Whether this took place before or subsequently to the rise of the temple to its present level, does not appear; but the pavement of the area is at present *level* with the waters of the Mediterranean.

The author then states several facts, which prove that considerable alterations in the relative level of the land and sea have taken place in the immediate vicinity. An ancient sea-beach exists near Monte Nuovo, two feet above the present beach of the Mediterranean;—the broken columns of the Temples of the Nymphs and of Neptune, remain at present standing *in the sea*;—a line of perforations of Modiolæ, and other indications of a water-level 4 feet above the present sea, is observable on the sixth pier of the bridge of Caligula: and again on the twelfth pier, at the height of 10 feet;—a line of perforations by Modiolæ is visible in a cliff opposite the island of Nisida, 32 feet above the present level of the Mediterranean.

The author considers the preceding inferences as a legitimate induction from the observed and recorded facts: and proceeds to suggest an explanation of the gradual sinking and subsequent elevation of the ground on which the temple stands. From some experiments of Col. Totten, recorded in Silliman's Journal, he has calculated a table of the expansion, in feet and decimal parts, of granite, marble, and sandstone, of various thicknesses, from 1 to

500 miles, and produced by variations of temperature of 1°, 20°, 50°, 100°, 500° of Fahrenheit: and he finds from this table, that if the strata below the temple expand equally with sandstone, and a thickness of five miles were to receive an accession of heat equal only to 100°, the temple would be raised 25 feet;—a greater alteration of level than is required to account for the phenomena in question. An additional temperature of 50° would produce the same effect upon a thickness of ten miles; and an addition of 500° would produce it on a bed only a single mile in thickness.

Mr. Babbage then adverts to the various sources of volcanic heat in the immediate neighbourhood: and he conceives that the change of level may be accounted for by supposing the temple to have been built upon the surface of matter at a high temperature, which subsequently contracted by slowly cooling down;—that when this contraction had reached a certain point, a fresh accession of heat from some neighbouring volcano, by raising the temperature of the beds again, produced a renewed expansion, and which restored the temple to its present level. The periods at which these events happened are then compared with various historic records.

The second part of this letter contains some views, respecting the possible action of existing causes, in elevating continents and mountain-ranges, which occurred to the author in reflecting on the preceding explanation. He assumes as the basis of this reasoning the following established facts:

1. That as we descend below the surface of the earth at any point, the temperature increases.
2. That solid rocks expand by being heated; but that clay and some other substances contract under the same circumstance.
3. That different rocks and strata conduct heat differently.
4. That the earth radiates heat differently, or at different parts of its surface, according as it is covered with forests, with mountains, with deserts, or with water.
5. That existing atmospheric agents and other causes, are constantly changing the condition of the surface of the globe.

Mr. Babbage then proceeds to remark, that whenever a sea or lake is filled up, by the continual wearing down of the adjacent lands, new beds of matter, conducting heat much less quickly than water carries it, are formed; and that the radiation, also, from the surface of the new land, will be different from that from the water. Hence, any source of heat, whether partial or central, which previously existed below that sea, must heat the strata underneath its bottom, because they are now protected by a bad conductor. The consequence must be, that they will raise, by their expansion, the newly formed beds above their former level;—and thus the bottom of an ocean may become a continent. The whole expansion, however, resulting from the altered circumstances, may not take place until *long* after the filling up of the sea; in which case its conversion into dry land will result partly from the filling up by detritus, and partly from the rise of the bottom. As the heat now penetrates the newly formed strata, a different action may take place; the beds of clay or sand may become consolidated, and may contract instead of expanding. In this case, either large depressions will occur within the limits of the new continent, or, after another interval, the new land may again subside, and form a shallow sea. This sea may be again filled up by a repetition of the same processes as before:—and thus alternations of marine and freshwater deposits may occur, having interposed between them the productions of dry land.

Mr. Babbage's theory, therefore, may be thus briefly stated.—In consequence of the changes actually going on at the earth's surface, the *surfaces* of equal temperature within its crust, must be continually changing their form, and exposing thick beds, near the exterior, to alterations of temperature; the expansion and contraction of these strata will probably form rents, raise mountain-chains, and elevate even continents.—The author admits that this is an hypothesis; but he throws it out, that it may be submitted to an examination which may refute it if fallacious,—or, if it be correct, establish its truth,—because he thinks that it is deduced directly from received principles, and that it promises an explanation of the vast cycles presented by the phenomena of geology.

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